Curtis (Ed. M.)

Compliments of the Author.

Why Do We Wear Spectacles?

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WHY DO WE WEAR SPECTACLES?

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"WHY DO WE WEAR SPECTACLES?"

When desired, a short time since, by your Committee of Arrangements, to read a paper on some ophthalmological subject before this society, I at first hesitated; I had but recently arrived among you, the weather was warm and I decidedly indolent; but on reflecting upon the great abuse and misuse to which those tender and delicate organs (our eyes) are subjected, and upon how little is known by the majority of people in regard to their proper use and wonderful functions, I concluded that a few words, even on so dry a subject as why we wear spectacles, might prove of interest.

It is only twenty years since that eminent scientist and versatile genius, Professor Helmholtz, invented the ophthalmoscope. Previous to that time, no one had a correct idea of why spectacles were necessary, or of the exact manner in which they aided our eyesight; but by the scientific research and practical experiments of Donders, Helmholtz, Scheffler and their collaborators, with the aid of the ophthalmoscope and those exquisitely accurate mathematical instruments, the phacoidoscope and ophthalmometer, the discovery was made, in an incredibly short time, of the minutest physiological workings of the eye, and why and what glasses were necessary for each optical defect of that organ, with the greatest precision; greater perhaps than is attainable in any other department of mathematics; for the dioptics of the human eye dip more deeply into the higher mathematics than most of our legal

friends are aware, and when they say that medicine is not a science, say ignorantly yet truly, for it is a combination of many sciences, not the least of which are mathematics and law.

In order to form a correct idea of the necessity for spectacles, one must understand something of the physiology of the dioptic system of the eye. (See Fig. 1.) The cornea, aqueous

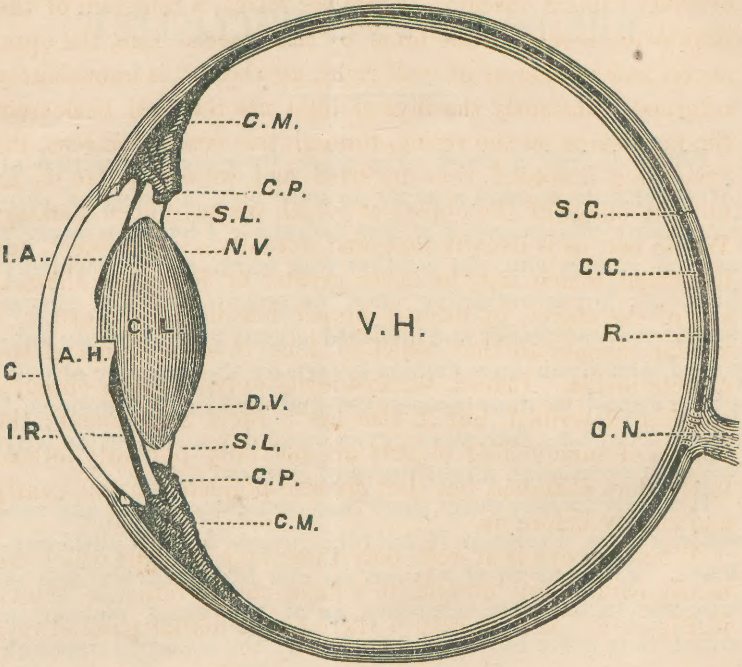

FIGURE 1. EXTENDED FROM JÆGER—ENLARGED LONGITUDINAL SECTION OF THE EYEBALL, THROUGH THE CORNEA AND OPTIC NERVE.

C., cornea; A. H., aqueous humor; C. L., crystalline lens; V. H., vitreous humor; S. C., sclerotic coat; C. C., choroid coat; R., retina; O. N., optic nerve; C. M., ciliary muscle; C. P., ciliary process; S. L., suspensory ligament of the crystalline lens; I. A., iris, when the eye is accommodated for near objects; it is seen to be nearer the cornea than when the eye is at rest or looking at distant objects as at I. R.; N. V., the upper half of the crystalline lens, down to the break in its anterior surface, shows it more convex and thicker—its condition when the eye is receiving divergent rays from near objects—than the lower half D. V., which is seen to be less convex, its condition when the eye is at rest or receiving parallel rays from objects eighteen or more feet distant.

humor, crystalline lens and vitreous humor, though each having a different index of refraction, may be considered as forming one powerful double convex lens, capable of converging parallel rays of light to a focus at its posterior surface on the retina, which is so prepared as to receive a correct image of objects, but in an inverted position, on account of the rays of light crossing each other in coming from the object to the retina, in the same manner that the image is formed in the ordinary camera obscura. From the retina, a telegram of the impression is sent to the brain by that special line, the optic nerve, and an answer of "all right, go ahead," is immediately returned. Instantly the rays of light are reflected back from the impression on the retina, through this compound lens, the eye, being a second time inverted, and we see before us an upright image of the object at which we have been looking. We do not, as is usually supposed, actually see the object, but its image, which may be made greater or less than the real size of the object, by using a proper lens before the eye, in a similar manner to that which is done in some forms of the camera lucida. Indeed, the eye is not only a camera obscura, as often described, but it also has a lucid attachment; the images of surrounding objects are not only perfectly formed in the dark chamber, but they are also projected magnificently and clearly before us.

When the eye is at rest, only those rays of light which are nearly parallel are brought to a focus on the retina, as shown in Figure 2. But in nature there are no actual parallel rays

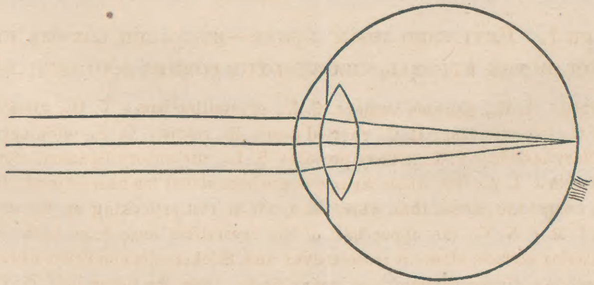

FIGURE 2. NORMAL SHAPED EYE AT REST, RECEIVING PARALLEL RAYS.

of light, as all rays which emanate from, or are reflected from, an object, diverge; yet all those rays of light which are so near each other as to pass through so small an aperture as the pupil of the eye, proceeding from objects eighteen or more feet distant from us, are near enough parallel for all practical purposes, and are considered, in optics, the same as emanating from objects at infinite distance. But when the object is nearer to us than eighteen feet, the rays of light become so divergent as not to be focused upon the retina without some change taking place in the eye; that is, if the eye remains at rest, in the same condition as when viewing objects more than eighteen feet from us, the rays of light from near objects would come to a focus behind the retina, as shown in Figure 3, and a blurred image would be produced on that membrane,

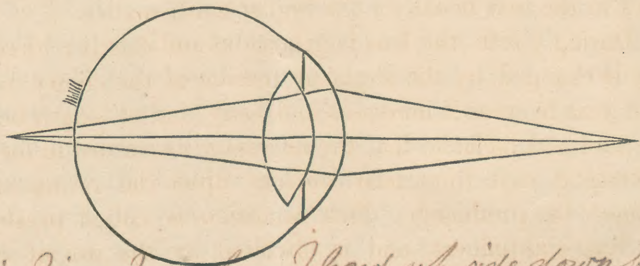

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FIGURE 3. DIVERGENT RAYS OF LIGHT FROM A NEAR OBJECT ARE BROUGHT TO A FOCUS BEHIND THE RETINA IN THE NORMAL EYE, IF IT REMAINS AT REST.

the object appearing indistinct. But we see near objects distinctly. How this was done was for a long time a mystery, many theories being adduced to explain it; but it has now been definitely ascertained by Helmholtz, Müller and others, that the crystalline lens increases in convexity the nearer an object approaches the eye (Fig. 1), so that for every increase in divergence of the rays of light, there is a corresponding increase in the convexity of the lens sufficient to bring the rays to a focus on the retina, provided the eye is normal in structure and the lens has not become hardened by age. This

change of convexity, or act of accommodation as it is called, is brought about by the contraction of the ciliary muscle (C. M., Fig. 1), a small, circular muscle, situated between the iris and choroid in the median tunic of the eye. These changes are often compared to the screw which regulates the focus of a field glass, which must be changed for each different distance at which we wish to observe objects. Although this action of the ciliary muscle was plainly demonstrated fourteen years ago, yet as Dr. Jeffries aptly remarks, "You will rarely, to-day, find it in any of the works on optics studied at our universities and schools," which, on the contrary, abound in such nonsensical ideas as that old people must wear spectacles on account of flattening of the cornea; that the crystalline lens is a tough, gristly substance, and many similar assertions, hardly in accordance with that exactness one would expect to find in the text books on the higher mathematics.

During youth, the lens is gelatinous and elastic; its convexity is changed by the slightest tension of the ciliary muscle; but year by year it increases in density, and at length becomes so hard and inelastic that the necessary curvature to focus the diverging rays from near objects upon the retina can no longer be produced. This condition is called presbyopia, or long-sightedness, and is obviated by the use of convex glasses, which take the place of the usual increase of curvature in the crystalline lens in viewing near objects. It commences in persons with normal eyes when about forty, as is shown if they attempt to read any fine print or to do embroidery by a bad light. Spectacles are not usually necessary, however, before forty-eight, and few will confess that their eyes are failing them for several years later, when they are compelled by inconvenience and discomfort to procure glasses, having, as is sometimes the case, delayed the matter so long that the foundation is laid for future disease of the eyes, by their refusing to use those aids to vision persistently demanded by nature and approved by both science and experience.

The normal eye has no need of glasses till the commence-

ment of presbyopia; but if the eye be abnormal in form an error of refraction will be present and glasses may become necessary at a much earlier age. In hypermetropia—or over-sightedness, a condition of the eye first accurately described by Prof. Donders of Utrecht, twelve years ago—the antro-posterior diameter of the eyeball is shorter than natural. We saw in the normally constructed eye that the retina was at such a distance from the lens that parallel rays of light were brought to a focus upon its surface without any effort of accommodation; now if by any means the retina be brought nearer to the lens, the focus for parallel rays would fall behind its surface, on which circles of dispersion would be formed so that the outline of objects would be blurred and indistinct; and this is what actually takes place in hypermetropia as shown in Figure 4. But if a convex lens be placed before such

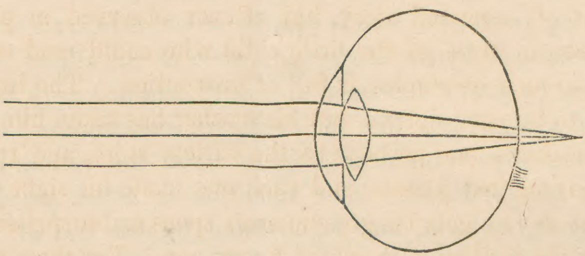

FIGURE 4. SHOWING THE FORM OF THE HYPERMETROPIC EYE, ANTRO-POSTERIOR DIAMETER TOO SHORT.

an eye, parallel rays are again brought to a focus on the retina (Figure 5); and in youth, if the error of refraction be not too great, the ciliary muscle by an extra effort may cause a sufficient convexity of the crystalline lens to overcome the difficulty; but as the lens becomes hardened by age, the power of the muscle is found to be insufficient to continue the increased convexity, necessary to see near objects clearly, for any great length of time, and symptoms of asthenopia—or weak sight—intervene. Patients complain that after reading or doing any close work for a short time, objects become indis-

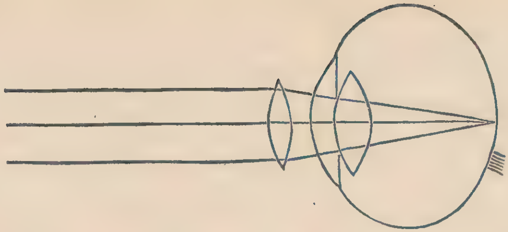

FIGURE 5. REFRACTION OF A HYPERMETROPIC EYE, CORRECTED BY A CONVEX LENS.

tinct, the eyes are blurred and feel tired, and if the occupation is persisted in, pain in and about the eyes supervenes. These troublesome symptoms cannot be avoided without the use of appropriate glasses, and the greater the amount of hypermetropia—that is, the shorter the eyeball—the earlier in life will glasses be necessary.

That oft repeated story, but oftener observed in practice than seen in print, of the little child who could read with his grandparent's spectacles, is full of instruction. The little one is said to be near sighted, but his mother has taken him to the watchmaker's, and perhaps to the variety store, and tried all the near sighted glasses, and each one made his sight worse; but one day he gets his grandmama's specs and surprises every one by the facility with which he can see. Yet these glasses, the very ones perhaps which he needs, are snatched away from him for fear they will make his eyes old, and he is left to grope his way in a perpetual haze, worse than a London fog or a continual twilight.

Nor is the uncertainty in regard to this trouble of the eyes confined to children. A very intelligent lady of twenty-five years, came to me complaining that she had always been near-sighted, but had never been able to find glasses that would benefit her. I saw at once, from the peculiar shape of her eye, that her trouble was quite the opposite of near-sightedness, in fact that she was hypermetropic, and on giving her proper glasses, she at once, and for the first time in her life, saw distinctly.

In myopia—or near-sightedness—the error of refraction is quite the opposite of that last considered, for while in hypermetropia the antro-posterior diameter is too short, in myopia it is too long (see Figure 6), the retina is too far from the lens, and

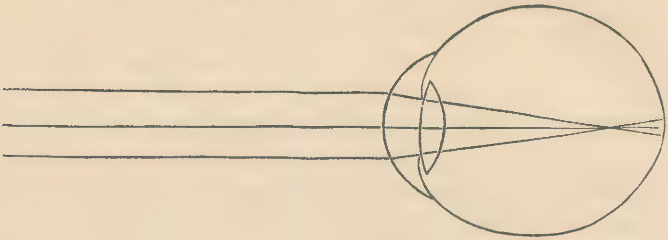

FIGURE 6. SHOWING FORM OF THE MYOPIC EYE, ANTRO-POSTERIOR DIAMETER TOO LONG.

parallel rays of light are brought to a focus and cross each other before they reach that membrane, on which circles of dispersion are formed, and indistinct vision is the result. But if a proper concave lens be placed before such an eye, the rays are rendered diverging, so that after entering the eye they are brought to a focus upon the retina. (Figure 7.) This is a more

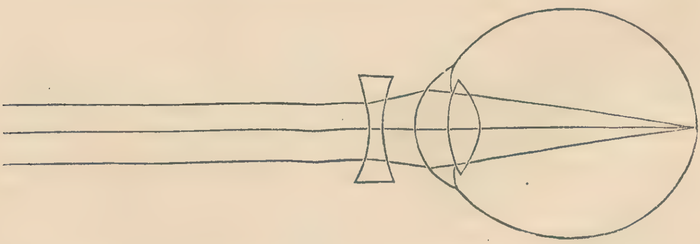

FIGURE 7. SHOWING REFRACTION OF THE MYOPIC EYE CORRECTED BY CONCAVE GLASS.

dangerous trouble than the former, being progressive in its character if aggravated by misuse of the eyes or by improper spectacles; it sometimes leads to the total destruction of all useful vision. We sometimes hear young persons congratulating themselves on being slightly myopic, for, they say, "we

shall not be obliged to wear glasses until we are very old," but, like the sword of Damoclese, I would consider the situation more dangerous than agreeable. Our great master in physiological dioptics, Prof. Donders, was the first to point out that "the near-sighted eye is not a sound eye," a changed condition of the retina and other coats of the eye about the optic nerve, called posterior staphyloma, is always present, and unless checked by appropriate care and treatment, may result most disastrously. This is the most frequent anomaly of refraction, especially among the educated classes. Recent examinations of over fifteen thousand students and school children, made in different parts of Europe by Dr. Cohn and others, revealed the fact that from fourteen to sixty per cent. were near-sighted—the percentage increasing in direct ratio with the grade of the school. The most prominent causes of this were found to be defective light and badly constructed school furniture, though the misuse of eyes already commencing to show myopia, and improper spectacles, had much increased the trouble. All school rooms should be thoroughly and properly lighted; the light should come to the seat from the sides and not from the front or back. The seats and desks should be so arranged that the scholars' books are at a proper distance from their eyes when they are sitting upright; as the stooping posture, long continued, must induce congestion of the ocular vessels, and thus may cause myopia, as well as increase it when it has already commenced. On looking into such eyes with the ophthalmoscope, the changed condition of the retina and choroid is readily seen, and the ophthalmic surgeon is enabled to pronounce whether the disease is progressive or stationary, and what amount of work the eye may safely perform.

Another error of refraction, which has been known for many years, but to which little attention has been given, is astigmatism; it is usually dependent on irregularity in the curvature of the cornea, in consequence of which, rays of light which enter the eye in a perpendicular meridian are not brought to a focus at the same point as those which enter the eye horizontally; portions of an object—those from which the rays are

focused upon the retina—are in that way seen plainly, while other parts are indistinct, as for instance in Figure 8, if a person sees at a distance of six feet, all the different sets of parallel lines with equal plainness, and they are all equally black, the

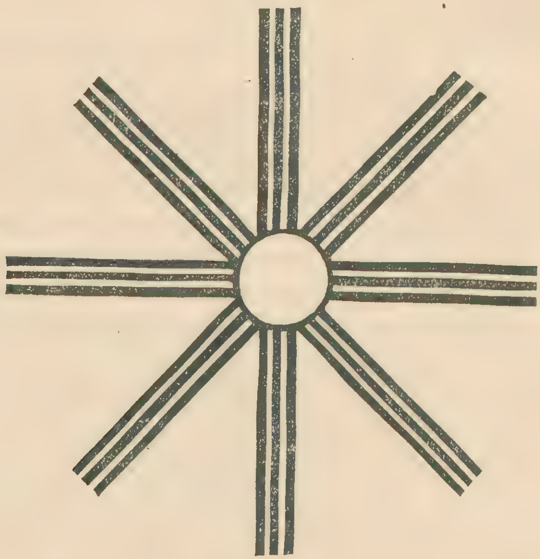

FIGURE 8. A TEST FOR ASTIGMATISM.

cornea is symmetrical; but if a part of them appear darker than the others and are more clearly defined, the person has astigmatism, which may be neutralized by a peculiarly shaped glass, ground to correct the differences in curvature of the different meridians of the cornea. These glasses are called cylindrical, and are often combined with the ordinary convex and concave spherical glasses.

A young lady, aged eighteen, applied to me some three years since. Her sight had been bad from infancy, and though constantly changing spectacles, she had never found any that gave her good vision, and her eyes were growing weaker year by year. After a protracted examination, she was fitted with a combination of spherical and cylindrical concave glasses, and

on stepping to the window and looking upon the crowded street, she exclaimed in grateful tones, "how wonderful; I have never seen objects distinctly before;" which was true. The poor girl had lived in semi-unconsciousness of all that was passing about her, and never till that day had she seen the outline of any object clearly defined.

So far we have answered the question of "Why do we wear Spectacles?" by showing that every person with natural eyes needs convex glasses as aids to perfectly accurate vision for near objects, before they reach the age of fifty; that hypermetropes, or persons whose eyeballs are too short, need convex glasses much earlier; that myopes, or those whose eyeballs are too long, need concave glasses early in life; while astigmatics, or those whose corneas are not symmetrical in curvature, need cylindrical glasses. There are besides these four great classes of people who need spectacles, occasionally others who should use them to counteract some especial trouble, as for intance, in aphakia, where the crystalline lens has been lost from injury, or after the operation for cataract, very strong convex glasses are needed. In cases of paralysis or weakness of the muscles of accommodation, the ciliary muscles, convex glasses are necessary for near objects. In cases of insufficiency or weakness of the recti muscles, prismatic glasses are sometimes necessary, and they are also used in some cases of strabismus or cross-eyes. Stenopaic glasses, or those which only admit the light through a narrow aperture, are of use in cases of irideremia or absence of the iris, in some high grades of myopia, and in some cases of opacity of the cornea. The periscopic glasses, comprising the positive and negative menisci, are only modifications of the ordinary concave and convex lenses, in the place of which they are frequently used. The pantoscopic or Franklin glass, named after their inventor, are ground with the upper and lower half of the glass of a different curvature, to suit the eye for different distances, but are not often used. The same object is sometimes accomplished by having the top of the spectacle frames flat, so that the eye can look over them at distant objects. Glasses for modifying

the intensity of the light are sometimes necessary, but much less often than they are used. In photophobia, or intolerance of light, blue glasses are preferable to green, for the reason that the latter exclude only the red rays, while the former absorb the orange, which are the most irritating to the retina of all the colors of the solar spectrum; but where the retina does not seem to be irritable, and we only wish to modify the amount of light, the neutral tinted glass is preferable. Goggles are rarely of benefit, as their wire frames are apt to overheat the eye. Those who are in the habit of using them in crossing the alkali plains and among the snows of the Sierras, would find the eye-protectors, made of thin glass, shaped like watch crystals and of a mild, neutral tint, more comfortable and beneficial, as they set closely to the eye on all sides but the temporal, where a sufficient amount of air is admitted to keep the eye cool and evaporate any undue moisture. Thick plates of plain glass or pieces of clear mica are also useful in protecting the eyes in some employments like stone cutting, needle grinding, etc.

It of course would be very weak and foolish to advance so absurd an idea as, that a person should wear glasses whose eyes do not need them; yet it is just as puerile, besides being productive of harm, to say that none should use spectacles so long as they can avoid them. The man who has suffered amputation of the thigh, walks very well by the aid of a properly adjusted artificial limb; persons who have lost their teeth get along very nicely with a well constructed artificial set; and people whose crystalline lenses are incapable of performing their natural functions, or have lost those valuable appendages, are just as much in need of artificial lenses—or spectacles—as an aid to sight, as are the two previous classes to their accessory adjuncts. Yet there is a wide spread popular prejudice against the use of spectacles, for which it is very hard to assign a reason. Perhaps it arises from the idea that if one commences the use of spectacles they will always be obliged to wear them, which is not universally true. The use of glasses does not in itself increase the need for them, any

more than the use of a cane increases lameness. If the difficulty for which the glasses are given should pass away, as it sometimes does, they might as readily be laid aside as are the crutches of the rheumatic patient on recovery from illness, and it would be just as reasonable to refuse the latter the aid of his crutches at a time when he must of necessity walk as it is to hesitate in giving spectacles to those people whose ciliary muscles are constantly, but vainly, striving to overcome some error in refraction.

Every person, before the age of fifty, would be more or less benefited by the aid of glasses; at least one in every three would perceive that benefit by the age of forty; one in every five by the time they are thirty, and one in ten as early as the age of twenty. Although this estimate may seem enormous, it is actually less than the percentage of cases of errors in refraction that have been found whenever the eyes of large numbers of individuals have been examined. But no one expects that all who need glasses will be persuaded to use them; the prejudice against them is too deeply seated in the popular mind; and ophthalmic surgeons will be well content if, by showing their necessity, they can persuade those whose sight is being slowly destroyed by the non-use and abuse of spectacles to a proper use of those wonderful accessories to vision.